Lesson-12

R7C1A2

Symmetry

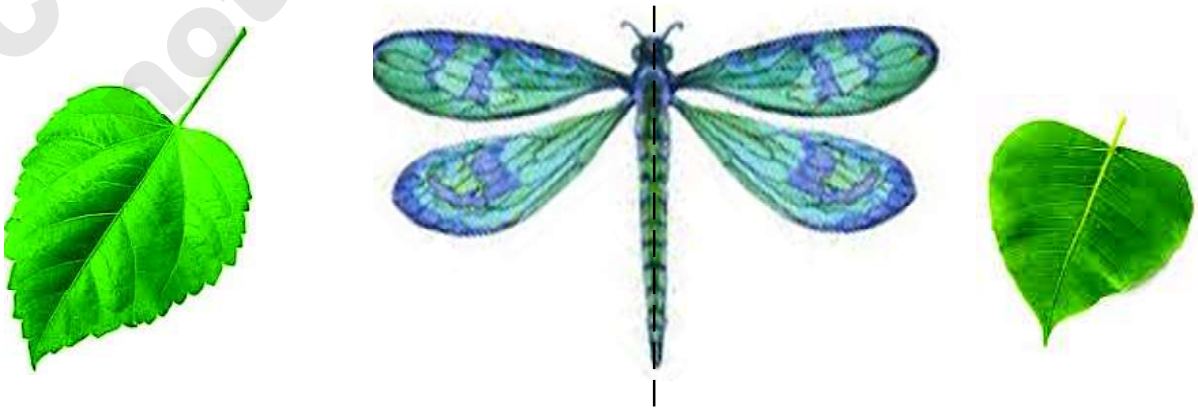
We see many things around us. Some of them are beautiful to look at because of their characteristic appearance. For example, the different types of butterflies, leaves of trees and creepers, insects and various other living organisms where we can see their diverse characteristics of appearance.

We feel happy when we see a dragonfly. The different parts of its body or the colourful patterns are arranged equally or identically on either side along the centre of its body.

The characteristic feature for which we find the dragonfly, spider appealing, in the language of geometry it is called 'Symmetry'.

Understanding symmetry

Around our physical surroundings we find many substances, trees and creepers or different living organisms with special characteristic appearance which can be explained with symmetry. For example, if you observe a butterfly resting on a flower you will notice that its wings, stings, eyes and other parts of its body are uniformly spread out on both sides. This means you can imagine it to be divided into two halves in which one half match exactly with the other half.



When we observe minutely the characteristic features of the dragonfly, different kinds of caterpillar, grasshopper, mosquito, fly etc. become apparent.

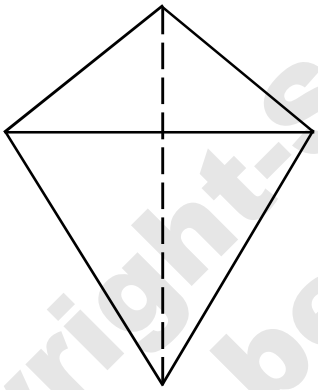


This characteristic feature is seen even in different kinds of flowers, petal, leaves, or in array of leaves etc, which means in each of them we will get atleast two halves and each half will match exactly with the other.



Array of tamarind leaves Leaves of gourd Nayantara

Look at the picture given below.




Just like the examples that we have discussed, the dotted line divides this kite equally into two halves, and if you fold the kite along the dotted line you will find each half matches exactly with the other. We can state this fact in another way also.

Suppose, we place a mirror on the dotted line. The image that will be formed in front of the mirror will fall exactly on the part which is at the back of the mirror. Therefore, each one of the two halves produced by the dotted line is the mirror of the other. In this way, if a picture is folded along a line and one fold matches with the mirror image of the other then, the characteristic feature of the picture is said line symmetry and the picture is said to be symmetrical about the line which divides the picture. The line that determines the symmetry of the picture is called line of symmetry or an axis of symmetry.

Therefore, the kite is symmetrical in shape. For the same reason, caterpillar, butterfly, mosquito and fly, ant, array of tamarind leaves and the leaves of gourd, nayantara and petals of a flower all these are symmetrical in shape. In nature you will find more examples of such.

Note that the concept of symmetry and line of symmetry is very close. When we say that a figure has an axis of symmetry it means the figrue is symmetric and a symmetric figure means it has a line of symmetry or an axis of symmetry.

Look at the figures given below-



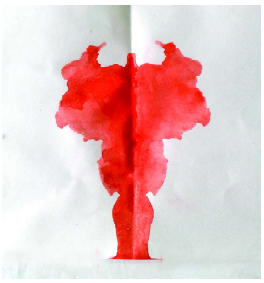

Are these shapes symmetrical?

Making symmetric figures

If we divide a figure into two halves and place a mirror on the line of division then by examining whether the image of one side matches exactly with the other or not we can find out whether the figure is symmetric or not. But, we can make symmetrical by using some techniques.

(i) Making symmetric figures by using ink blot on paper

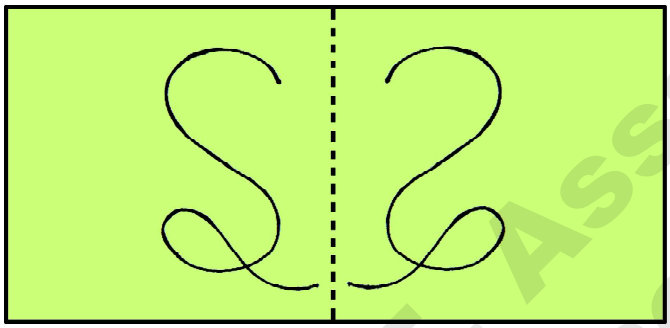
Fold a plain white paper in the middle. Spill a drop of ink on one half side of the paper and press the other half on it. Open the fold and allow the paper to dry. You will notice that the ink blot has created a symmetric figure in the figure, the fold of the paper is the axis of symmetry.



You can create figures of different shapes by spilling ink drops in different ways and can make accordingly symmetric figures of different designs. You can make various symmetric figure not only by creating figures of different shapes with ink blots but also by changing the position of the fold of the paper.

(ii) Formation of symmetric patterns with coloured thread on paper

Take a piece of thread from a reel and dip it in ink or other coloured paint. Now place the coloured thread on one fold of a paper and press it on with the other fold. If you open the fold and remove the thread you will find a symmetric shape on the paper for which the fold of the paper is the axis of symmetry.



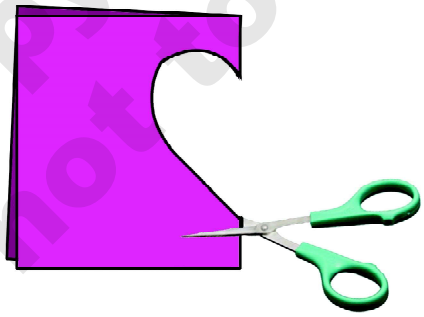
We may have various attractive symmetric shapes by making different shapes with the thread or by changing the position of the fold of the paper.

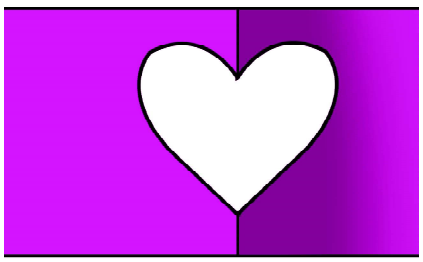
You prepare more of such colourful symmetric figures and place them beautifully in a suitable corner for exhibition.

(iii) Making of symmetric figure with scissor and paper

Fold a piece of paper. Cut out a shape with the fold. If you open the cut piece you will find a symmetric shape and the fold is the axis of symmetry of the cut figure.

We may have various symmetric figures of various shapes by making cut outs of different shapes from folded paper.

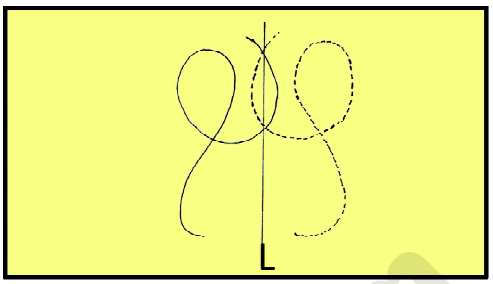




(iv) Formation of symmetric figures with tracing paper

As shown in the figure draw any shape on a piece of white paper. Suppose L is any line drawn on the paper.

Now, if you place a tracing paper on the picture you will see it clearly. So you can trace the picture L on the tracing paper with a pencil. Kept the tracing paper in such away that the L on the white paper and the L on the tracing paper coincides with each other.



Now the figure in the tracing paper will match exactly with the mirror image of the figure on the white paper. Now if you press pencil and draw the figure on the tracing paper that you see from the opposite side you will find the impression of the figure on the white paper. If you remove the tracing paper and draw the impression with a pencil you will get the symmetric figure.

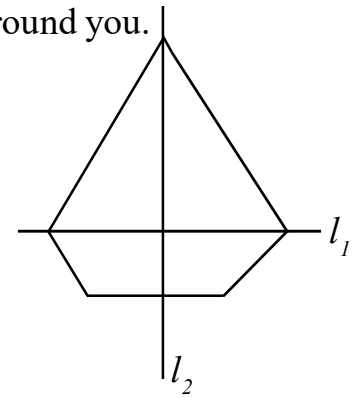
In this way by using different patterns you can make symmetric figures of them.

Till now you have learnt about symmetric figures and axis of symmetry. You have also learnt how to make symmetric figures by using different methods. Make a list of objects which you find in and around your home and with the knowledge that you have gained identify which of them are symmetric.

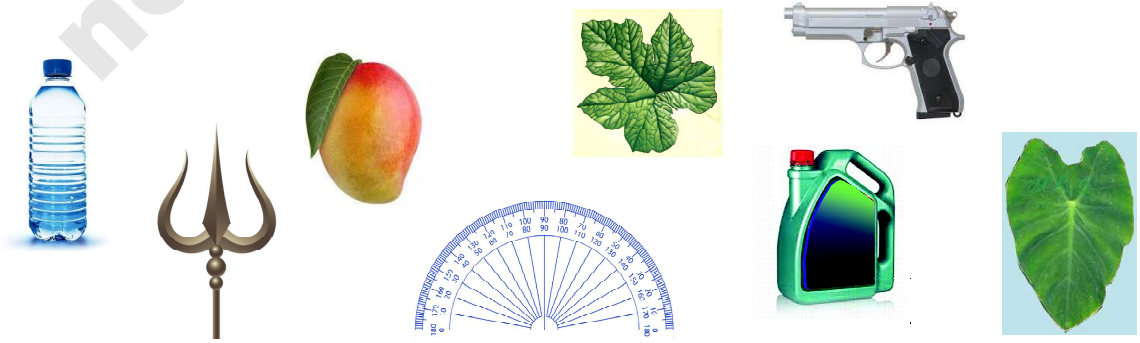
Try these

1. List five symmetrical objects which you find in and around you.

2. Identify the mirror line on the line of symmetry from the lines shown in the symmetrical figure.

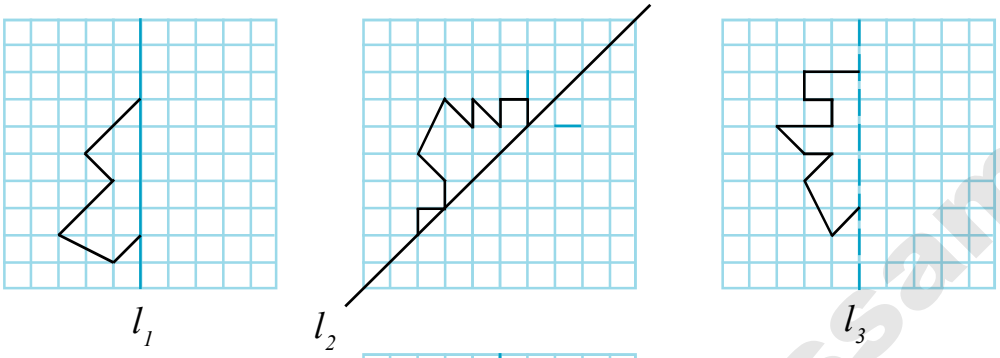


3. Identify the symmetrical figures from the figures shown below. Also draw the mirror line or the lines of symmetry for those figures.

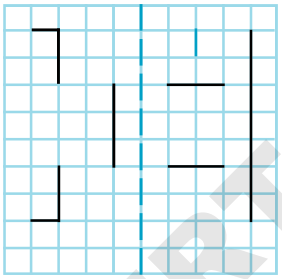


4. The following picture drawn on the graph paper show lines l_1, l_2, l_3 . Complete the pictures in such a way that they are symmetrical about the given lines.

Fig



5. Is the shape shown in the adjacent figure symmetrical about the given line *L*? If not, is there any way to make it symmetrical?

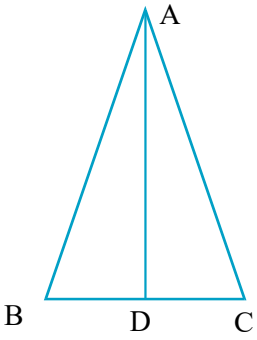


Fig

6. Use a tracing paper to make a symmetrical shape taking the given line L as the line of symmetry.

Figures with one line of symmetry:

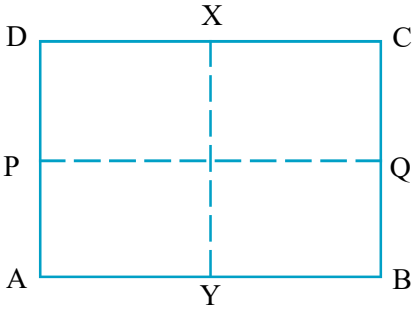
Make a cut out of an isoscleles triangle from a piece of paper. Fold the triangle in such a way that the two halves matches each other. How many folds did you get? Certainly not more than one. From the figure it is clear that only the fold along the line AD will give us two halves which will coincide with each other. Therefore, in this case we will have only one line of symmetry.



Figures with two lines of symmetry:

Now take a rectangular piece of paper.

As done in the case of isosceles triangle, try to fold the rectangular piece of paper in such a way that the two halves matches completly with each other.

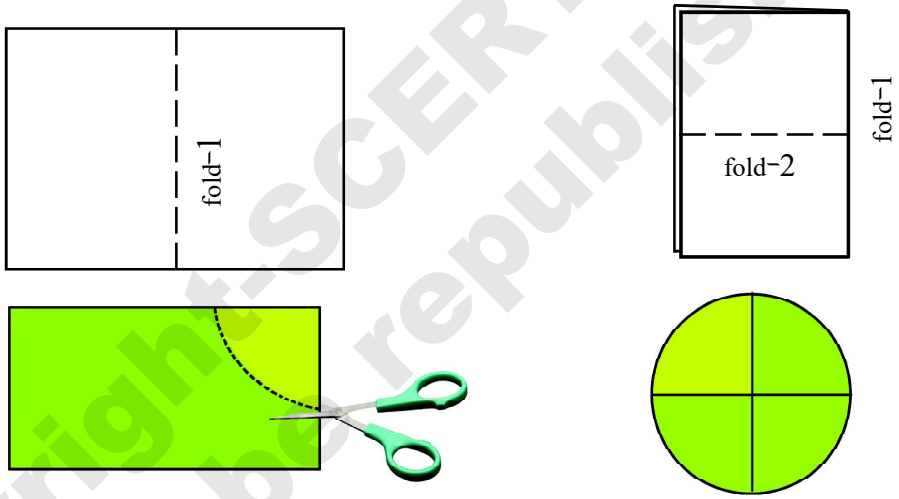


In how many ways can you fold? After a number of attempts you will under stand that you can have two identical division only in two ways. This means that except PQ and XY there are no other lines of symmetry.

Can you make a symmetrical figure with two lines of symmetry?

We have already discussed how we can construct a symmetrical figure with one line of symmetry by cutting folded papers with a pair scissors. Can you have a figure with two lines of symmetry by using this same method?

Take a piece of paper. First make a fold centrally along its breadth. Now without opening the fold, fold it again so that the two former folds falls on each other. Without opening the folds cut out a piece of any shape with the scissors. Take care so that the point where the two folds intersects each other reamanis in the cut piece. Now you open the folds. You will find a symmetrical figure where the two folds are the lines of symmetry of the figure.



You can make more figures of symmetrical figures by cutting pieces of folds of different shapes with the scissors.

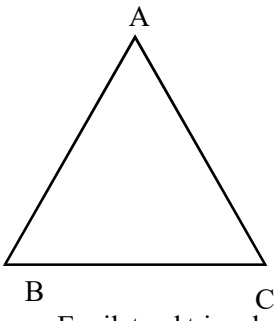
Figures with more than two lines of symmetry

Take an equilateral triangle ΔABC. In how many ways can you divide the triangle so that the two halves matches with each other?

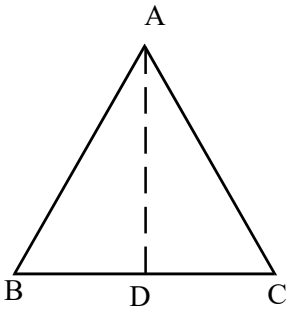
Draw an equilateral triangle ΔABC in a piece of paper and cut it out with a pair of sicssors. Now fold the triangle in such a way that the point B falls on C. If you press the folds there will be an impression in the triangle such that the fold will touch A and the midpoint D of BC.

Similarly, If E and F are the midpoints of BE and CF, then BE and CF are the two other lines of symmetry of the triangle ABC.

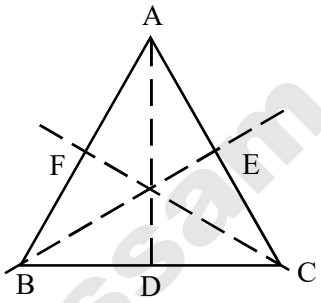
This means an equilataral triangle is a symmetrical figure whose lines of symmetry are three.



Equilateral triangle

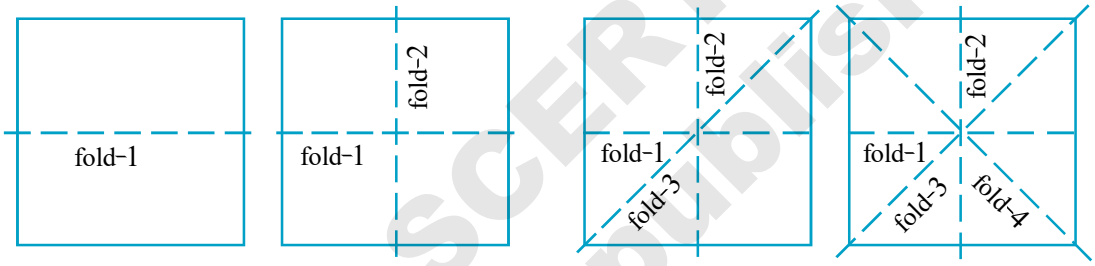


AD is line of symmetry



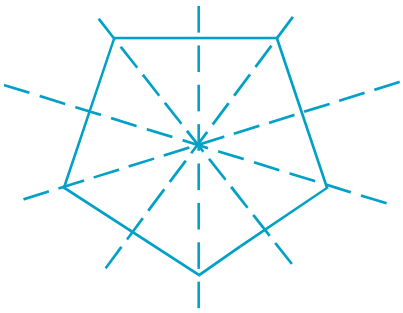
Equilateral triangle and its three lines of symmetry

Now you take a paper of square size. Try to make as many folds a you can so that both the folds falls on each other completly.



So, in the case of a square sized paper we get a total of 4 lines of symmetry.

Are not the dotted lines represents lines of symmetry in the figure ?



How many lines of symmetry are there?

What have we learnt?

Equilateral triangle is a symmetrical figure which has three lines of symmetry.

A **Square** (which has four sides, and four angle which are equal to each other) is a symmetrical figure and it has four lines of symmetry.

A regular pentagon (which has all the sides, and all angles equal) is a symmetrical figure and it has five lines of symmetry.

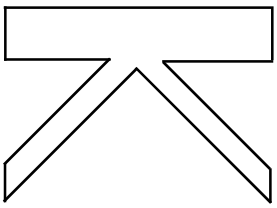
Can we arrive at a conclusion now? Discuss, what we have learnt about lines of symmetry of a regular polygon.

Try these

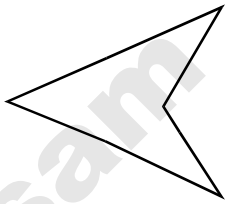
1. How many lines of symmetry are there in the figures given below?

(a)

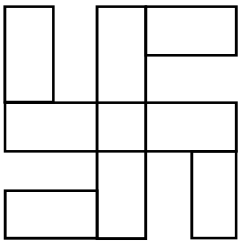
(b)



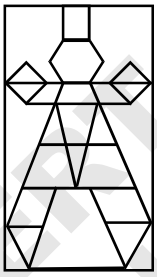
(a)



(d)



(e)



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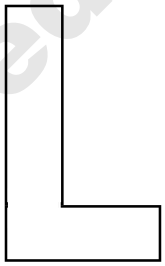
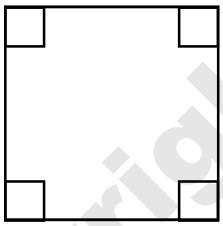
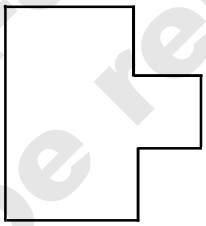


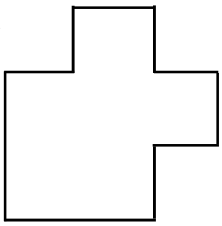
(g)



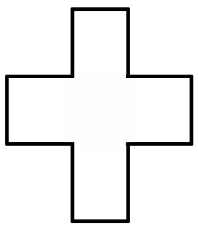
(h)



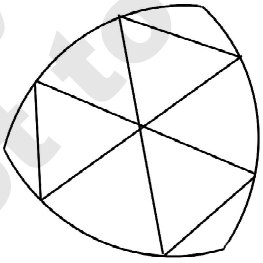
(i)



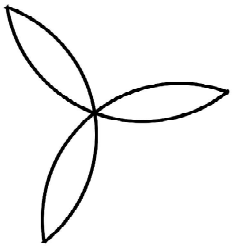
(j)



(k)



(l)



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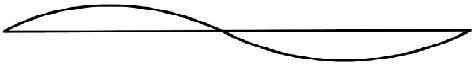
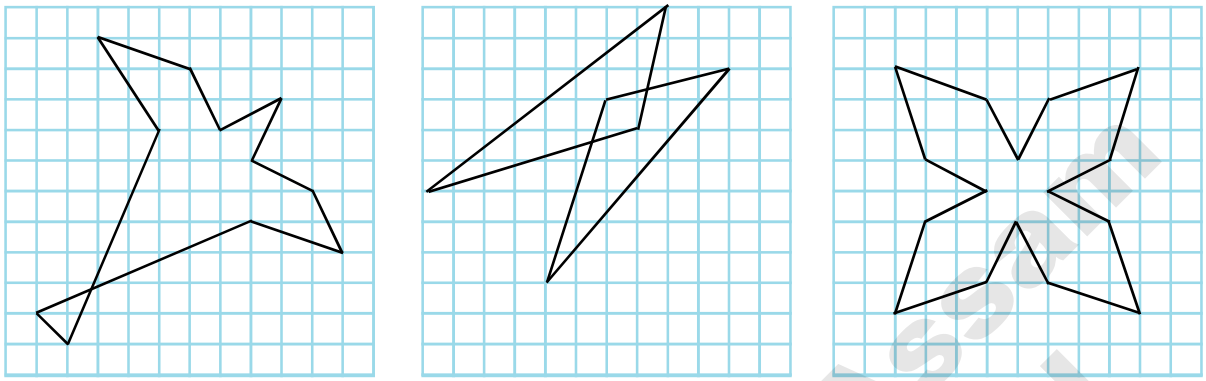


(n)

2. Below are given a few geometric figures drawn on the graph paper. Draw the lines of symmetry in each figure.



(a) (b) (c)

	Shape		Number of lines of symmetry
1	Line	(of any length)	1
2	Triangle	(a) Scalene (b) Isosceles (c) Equilateral	
3	Quadrilateral	(a) Square (b) Rectangle (c) Rhombus (d) Parallelogram (e) Trapezium	
4	Pentagon	Pegular pentagon	
5	Hexagon	Regular hexagon	

4. Considering the numerals 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 as geometrical figures mention which figures are symmetrical. Also mention the number of lines of symmetry in each symmetric figure.

5. Consider the capital letters of English alphabets as geometric figures and prepare a list of symmetric figures. Also mention the number of lines of symmetry in each symmetric figure.

6. Draw a triangle which has

   (a) One line of symmetry

   (b) Three lines of symmetry

   (c) No line of symmetry

7. Draw on graph paper

   (a) A triangle which has a horizontal line of symmetry.

   (b) A quadrilateral which has a vertical line of symmetry but no horizontal line of symmetry.

   (c) A quadrilateral which has a horizontal line of symmetry but no vertical line of symmetry.

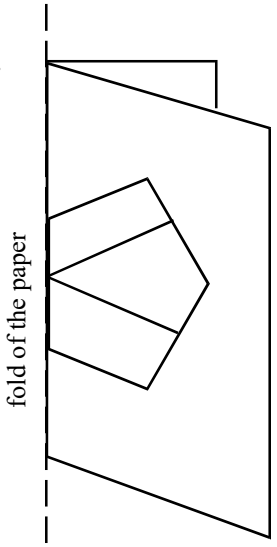
   (d) A quadrilateral which has a vertical line of symmetry but no horizontal line of symmetry.

   (e) A quadrilateral which has a vertical line of symmetry and a horizontal line of symmetry.

   (f) A pentagon which has a vertical line of symmetry.

   (g) A hexagon which has a vertical line of symmetry.

8. In the figure a part of the symmetrical figure of a piece of paper is shown. Considering the fold of the paper as the line of symmetry complete the figure.

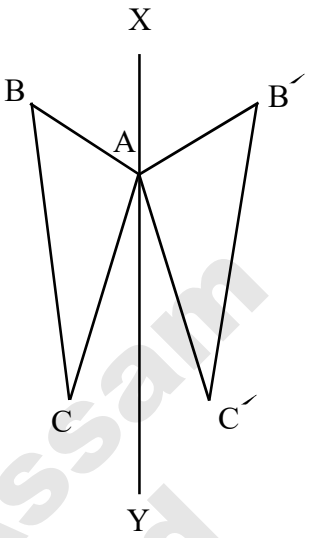


Reflection and symmetry

We have already noticed that the symmetric property of any shape can be explained by the phenomenon of reflectioin of light by mirror. This means there is a relation between reflection of light mirror and symmetric figure. We can understand this relation with a simple activity.

Draw a straight line in the vertical direction with a ruler on a paper. Keep a set square from your geometry box on the left hand side of XY as shown in the figure. Now, if you keep a mirror on the line XY you will see the reflection of the set square in the mirror.

Now, with ruler and set square take two points C´ and B´ on the right hand side of XY so that B, B´ and C, C´ are at equal distance from XY respectively. Join AB´, AC´ and B´C´. Note that not only B, B´ and C, C´ are at equal distance from XY, but also



$BC = B'C'$, $AC = AC'$, $AB = AB'$, $\angle BAC =$, $\angle B'AC'$ $\angle ABC = \angle AB'C'$ and $\angle ACB = \angle AC'B'$

(Do the measurements with a ruler and a protractor)

Does this not mean that ABC is similar to ABC just like $AB'C'$ is a mirror image of ABC? If you fold the paper along XY then, will not $\Delta\, AB'C'$ match exactly with Δ ABC? Does this not mean that the figure is symmetrical about XY?

What have we learnt from the activity?

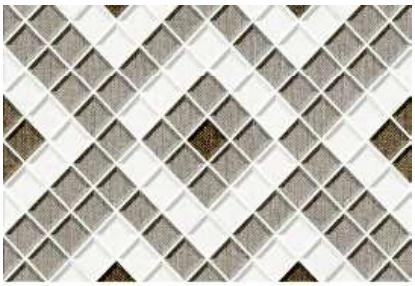
What have we learnt from the activity?

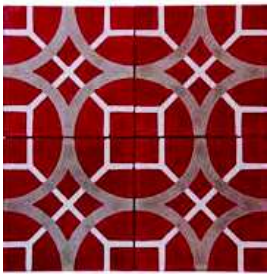
When a figure is symmetric, there is at least one line of symmetry which divides the figure into two parts in such a way that the corresponding lengths, angle etc. in the two parts are same.

1. **Use of symmetry in beautification**

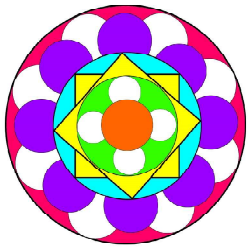
From ancient times the idea of symmetry has attracted the minds of the people of fine arts or the artists. One can find beautiful examples of symmetry in the sculptures, art works, temples, mosques, churches of older times.

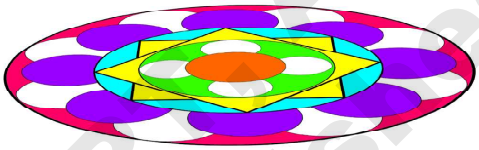
2. We find application of symmetry in most of the tiles used in floors, walls etc. in houses.



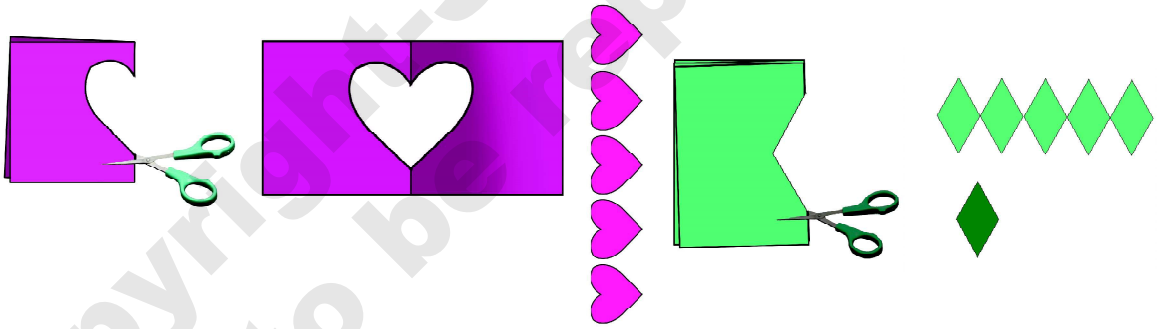


3. The idea of symmetry is also used in drawing alpanas for auspicious occasions at home or for decorations in public meetings.





4. In celebrations of marriage, religious functions decorations are done with very beautiful colourful designs of paper cut-outs. Symmetry is applied in making the designs.



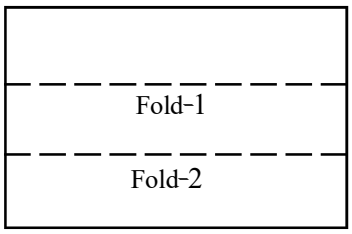
Let us make a kaleidoscope

The idea of reflection symmetry is used in making a kaleidoscope. It is an interesting instrument making principle which is based on the phenomenon of reflection of light.

Take a rectangular strip of special type of plastic that can reflect light. With a scale make the strip at three equal lengths.

Folding it along the markings as shown in the figure make a triangular shaped pyramid. Fold a cardboard to make a circular tube and insert the triangular pyranid in it. Close one end of the tube by a cardboard disc and make a small hole in the center.

At the other end insert a thin transparent piece of polythene and put some small colourful bangles, beads inside. Now close the end with a transparent polythene. Now, holding it towards a source of light if you peep through the hole you will be able to see a variety of symmetric patterns.



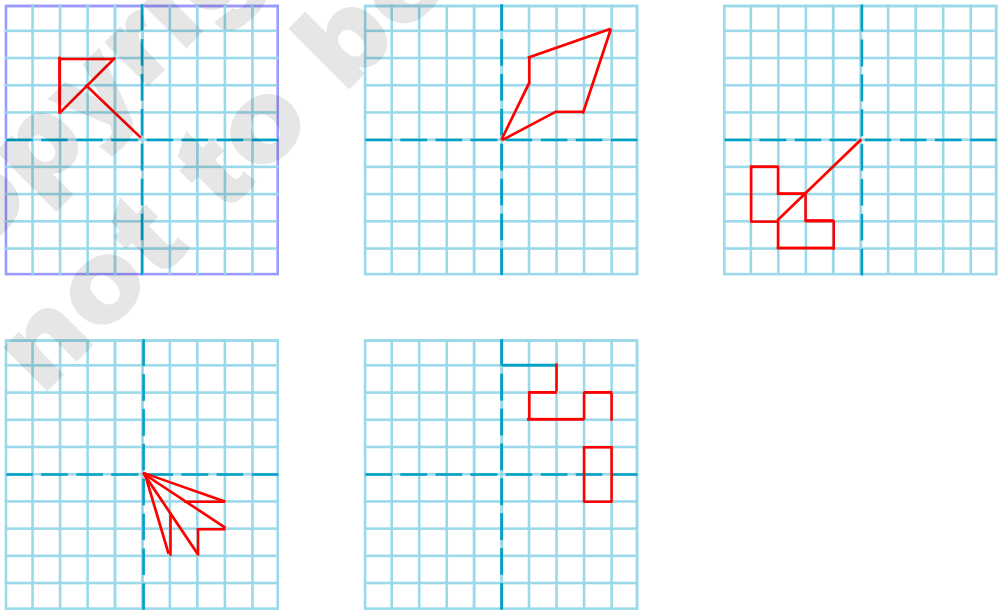
Reflecting rectangular strip of plastic

Triangular pyranid

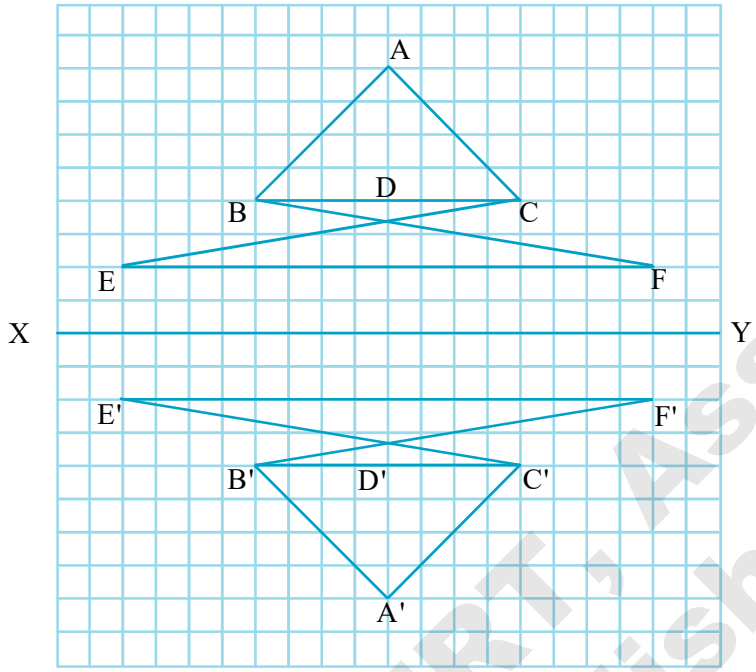
Outer covering made of cardboard

Try these

1. Below are given some figures drawn on graph papers. Draw and complete each of them such that the resulting figure is symmetric about the given vertical line, horizontal line and both the lines.



2. A figure is given below in the graph paper. From the figure



(i) Find the distance of the points from XY (use scale if necessary) and say if there is any interelationship between them.

(ii) Find the length of the line segments used for drawing the figure. Mention if there is any relationship between the lengths.

(iii) With the help of a protractor measure the included angles formed by the adjacent lines. Mention if there is any mutual relatioship between the angles.

(iv) Is the figure symmetric? If yes identify the line/ lines of symmetry?

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Instruction to teacher: *The teachers will discuss with the students.*